Such an application may be useful in lab-on-a-chip or μ-TAS systems wherein streams of various concentrations are desired. Several embodiments of the present invention may be used in series, such that one stream is separated and split, then separated and split again, with the end result being several outlet streams with differing dilutions of the original incoming stream. Such a system is known as serial dilution.

[0059] **FIG. 11** illustrates an embodiment **1100** of a four-well mixer that was analyzed with computational fluid dynamics techniques for variations in the present invention. The computational analyses were designed to correspond to the experimental results shown in the previous figures. The channel geometry and fluid properties were selected to closely match those of the experiments. The inlet **1102** contains a buffer fluid with Rhodamine B that is mixed with a second inlet **1104** that contains only the buffer fluid. The fluid exits the embodiment **1100** via the outlet **1105**. The four wells **1106**, **1108**, **1110**, and **1112** are located at an angle theta **1113** from the centerline axis of the mixer. The geometry of the embodiment **1100** is similar to the previous embodiments described herein. Cross-section line A **1114** will be used to illustrate the incoming streams prior to mixing. Cross-section line B **1116** will be used to illustrate the mixing of the streams while in the well **1112**, the last of the four wells. Cross-section line C **1118** will be used to illustrate the mixing of the streams 5 μm past the exit of the last well. Cross-section line D **1120** will be used to illustrate the mixing of the streams at a location of 420 μm past the point of confluence.

[0060] **FIG. 12** illustrates some computational analyses of the flow patterns for various depths of wells, based on the embodiment **1100** shown in **FIG. 11**, with a constant well angle of 45°. The results for cross section A **1202** illustrate the two incoming flows **1204** and **1206** prior to mixing. The results for cross section B **1208** illustrate the flow patterns for the flow within the last of the four wells. The 10 μm depth results **1210** show that very little of the mixing is occurring in the well. The 50 μm depth results **1212** show that a substantial portion of the mixing is occurring in the well. The 85 μm depth results **1214** show that a substantial portion of the mixing is occurring in the well, but that there is not much increase in the mixing due to the larger depth over the 50 μm results **1212**. These results indicate that there is a finite depth wherein increasing the depth does not increase the degree of mixing substantially. Further, these results illustrate that the wells greatly affect the mixing by forcing the fluids to fold over each other.

[0061] **FIG. 13** illustrates the results of various angles of the wells as represented by the angle theta **1113** of **FIG. 11**. For all well angles illustrated, the depth of the wells was held constant at 50 μm below the bottom of the imprinted channel. The results of cross section B-B **1302**, cross section C-C **1304**, and cross section D-D **1306** are shown in columns. The results for the various angled wells are shown in rows. Results along row **1308** are for wells at a right angle or 90 degrees to the axis of flow. Results along rows **1310**, **1312**, and **1314** are for wells at 60 degrees, 30 degrees, and 15 degrees to the axis of flow. The results indicate that a decreased angle of the well achieves a higher degree of mixing.

[0062] The results along row **1308** for right angle wells show that there is no lateral transport across the width of the well. As the angle of the wells is decreased, there is increased lateral transport to the point where the flow may be folded over on top of itself more than once. The folding action is an important mechanism that causes efficient mixing.

[0063] **FIG. 14A** illustrates a plan view of the flow pattern of an embodiment **1400** of a mixer with quantity 4 wells oriented at 15 degrees off of the axis of flow, and well depths set to 50 μm below the bottom of the imprinted channel. **FIG. 14B** illustrates a cross sectional view of the flow pattern of **FIG. 14A**, as observed from the cross section E-E. The flow lines **1402** and **1404** illustrate that the fluid may exit the first well **1406** and reenter another well **1408** and thereby may fold during the passage through the mixer **1400**.

[0064] **FIG. 15** illustrates the results of changes in the electroosmotic (EO) mobility of the surfaces of the wells. Different manufacturing processes may create different EO mobilities on various surfaces of the channels. For example, of the manufacturing processes described for the experiments described elsewhere in this specification, imprinting a channel has been shown to yield a different EO mobility than the laser ablation manufacturing method. Further, other methods such as polyelectrolyte multilayers, surface chemistry modifications, EO mobility suppression coatings, and other methods may be used individually or in combination to selectively change the EO mobility of selective surfaces of the mixer.

[0065] The results of **FIG. 15** illustrate the effects of increasing the EO mobility of the surfaces of the wells with respect to the EO mobility of the remaining surfaces of the mixer. The results are for a four well mixer with 45 degree wells at a depth of 50 μm below the bottom of the imprinted channel. The column **1502** illustrates the results for section B-B, column **1504** illustrates the results for section C-C, and column **1506** illustrates the results for section D-D, all of which relate the cross sections illustrated in **FIG. 11**.

[0066] For the purposes of this discussion, a ratio of the EO mobility of the wells divided by the EO mobility of the remainder of the surfaces will be r_{EOM}. The row **1508** illustrates the results when r_{EOM} is 1.24. Row **1510** illustrates the results for r_{EOM} of 2.00 and row **1512** illustrates the results for r_{EOM} of 3.00. Row **1508** is illustrative of the approximate r_{EOM} of the experimental results described in **FIGS. 7, 8**, and **9**. The results indicate that as the r_{EOM} is increased, mixing can be enhanced. In other words, the increase of the EO mobility, by different manufacturing processes, selectively applied coatings, or other methods may dramatically increase the performance of a mixer of the present invention.

[0067] A use for the present invention is the mixing of plugs of fluid. Applications for such a use may be for lab on chip applications wherein several samples of fluid may be analyzed in succession. It would be desirable for the plugs of fluid to be efficiently mixed, but to minimize the axial dispersion of the plug.

[0068] **FIG. 16A** illustrates a plug of fluid **1602** introduced into the channel **1604**. The channel **1604** illustrates a case wherein the wells of the present invention are not present and represents a baseline case. The mixed plug **1606** is shown downstream.

[0069] **FIG. 16B** illustrates an embodiment of the present invention wherein a plug of fluid **1608** is introduced into a